REMARKS

After the foregoing amendment, claims 4-11, as amended, are pending in the application. Claims 1-3 have been canceled. Claims 10 and 11 are allowed. Applicant submits that no new matter has been added to the application by the Amendment.

Multicast Concentrator

1. A conventional concentrator is a point-to-point switch that routes 0-bound, 1-bound, and idle packets to 0- and 1-output groups.

2. A multicast concentrator is a multicast switch that routes 0-bound, 1-bound, idle, and bicast packets to 0- and 1-output groups.

3.. Definition of Multicast A connection state $T_0, T_1, T_2, \ldots, T_{m-1}$ from the array Inputs to the array Outputs is said to be a "point-to-point connection state" if every set T_j contains at most one element; otherwise, the connection state is called a "multicast connection state" (page 28, lines 3-5).

A switch is said to be point-to-point if every connection state in it is point-to-point, otherwise it is said to be multicast. In other words, a switch having only point-to-point connection states routes a signal on a single switch input to at most, a single switch output, whereas a switch having at least one multicast connection state may route a signal on a single input to a plurality of switch outputs.

Note that a connection state is an intrinsic characteristic of a switch. A connection request may not always be accommodated by the switch. For example, a request for a connection from an input to more than one output, that is, a multicast connection request, can never be accommodated by a point-to-point switch.

4. Definition of m-to-n multicast concentrator. For n<m, an mxm switch having a "0-output group" comprising the m-n outputs with the smallest addresses, that is, from 0 to m-n-1, and a "1-output group" comprising the remaining n outputs and receiving 0-bound, 1-bound, idle and bicast input signals is called an m-to-n "multicast concentrator" if it routes the maximum total number of 0-bound and bicast signals to the 0-output group and the maximum total number of 1-bound and bicast signals to the 1-output group (page 200, line17 – page 201,

line 4).

An m-to-n multicast concentrator, by its definition, always guarantees that the total number of 0-bound (resp. 1-bound) and bicast signals routed to its 0-output group is the maximum possible. This guarantee can be equivalently expressed as: by letting the numbers of 0-bound, 1-bound, bicast, and idle signals that arrive at an m-to-n multicast concentrator be x_o, x_1, x_b, and $m-x_0-x_1-x_b$, respectively, then the total number of 0-bound and bicast signals that arrive at 0-output group of the multicast concentrator is $\min\{m-n, x_o+x_b\}$, and the total number of 1-bound and bicast signals that arrive at 1-output group is $\min\{n, x_1+x_b\}$.

A multicast concentrator is a switch serving for the combined objective of concentration and multicasting. In the absence of bicast signals, its function reduces to the same as a conventional concentrator.

Rebuttal to the Examiner's Response to Amendment and Argument

In the Examiner's Response to Amendment and Argument, the Examiner characterizes the NxN interconnection network in Fig. 6 of Lee as a multicast switch. Also, the Examiner appears to state that the 3X3 switching element disclosed by Lee (Fig. 5) is a multicast switching element because it has three inputs and three outputs.

Applicant respectfully disagrees. Applicant is unable to find any teaching in Fig. 5, Fig. 6. or otherwise in Lee, that suggests Lee's invention is capable of routing a single signal on a single input to a plurality of outputs, as required for multicasting. As one skilled in the art would understand, in order for a switch to be a multicast switch, the switch must have at least one switching state in which a single input is connected to more than one output. At col. 8, lines 26-39, the basic switching element 500 of Lee's switch is described as a 3x3 switch without any reference to simultaneously connecting an input to more than one output. Further, each example in the reference, see Figs. 7, 9 and 10, describes point-to-point switching and does not teach or suggest that the 3X3 switch used by Lee has a switching state that simultaneously connects a single input to more than one output. Also, the operation of Lee's switch does not depend on the 3X3 switch element being capable of multicasting. Additionally, there is not one occurrence of the terms "multicast" or "multicasting" in Lee. Because the switch described by Lee does not teach or suggest at least one switch state that connects a single input to a plurality of outputs, the

switch disclosed by Lee can not be characterized as a switch which provides multicast switching as asserted by the Examiner.

Further, the Examiner appears to be equating a multicast switch with the multicast concentrator recited in claims 4 and 9. However a multicast concentrator is different from a multicast switch. As defined at page 200, line 17 to page 201, line 4: "for n<m, an mxm switch having an "0-output group" comprising the m-n outputs with the smallest addresses, that is, from 0 to m-n-1, and a "1-output group" comprising the remaining outputs and receiving 0-bound, 1 bound, idle and bicast input signals is called an m-to-n multicast concentrator if it routes the maximum possible total number of 0-bound and bicast signals to the 0-output group and the maximum possible total number of 1-bound and bicast signals to the 1-output group." In contrast to a multicast concentrator, a multicast switch routes input signals to the output ports based strictly on the output addresses provided by the control signal and does not route input signals to a group of output ports based on whether the input signal is 0-bound, 1-bound or bicast, as defined for the claimed concentrator.

According to the application, a multicast concentrator is used as a building block for constructing a multicast switch. Because a multicast concentrator provides a different function and has a different structure than a multicast switch, Applicant submits that the references Lee and Yang et al., which describe respectively a spread Omega network and a Benes network, do not disclose, teach or suggest a multicast concentrator.

Rejection - 35 U.S.C. § 103

The Examiner rejected claims 4 and 9 under 35 U.S.C. § 103 as being unpatentable over U.S. Patent No. 6,335,930 (Lee) in view of U.S. Patent No. 5,940,389 (Yang et al.). The Examiner states that Lee discloses in Fig. 6 a multicast switching network where each switching element comprises X bypassing input ports, M-X input routing ports, X bypassing output ports and M-X output routing ports. The Examiner states that Lee does not disclose bicast signals for routing in the network, but that Yang et al. discloses a system and method in which a control circuit generates control sequences of 01 and 10 as the "bicast" value for each input signal. The Examiner further states that it would have been obvious to a person of ordinary skill in the art at the time the invention was made to apply Yang et al's. enhanced

partially routing algorithm into Lee's interconnection network. Applicant respectfully traverses the rejection.

Lee discloses a bypassing Omega network The bypassing routing network performs self routing by using the routing address as the routing tag (col. 9, lines 65-68). Each switch element in the network includes an input bypassing port and an output bypassing port. Packets are routed to the output bypassing port of a switch element as a result of contention for the same output port (col. 10, lines 4-8).

Claim 4 recites:

> *An m-to-n multicast concentrator for routing input signals, each of the input signals being 0-bound, 1-bound, bicast, or idle, the concentrator comprising*
>
> *m input ports to receive the input signals,*
>
> *m output ports partitioned into two groups wherein m-n of the m output ports are grouped as a 0-output group and the remaining n output ports are grouped as a 1-output group, and*
>
> *means, responsive to the input signals, for routing the maximum possible total number of 0-bound and bicast ones of the input signals to the 0-output group and the maximum possible total number of 1-bound and bicast ones of the input signals to the 1-output group.*

Applicant first submits that Lee does not teach or suggest a switch: (1) receiving 0-bound, 1-bound, bicast and idle signals having m output ports, (2) partitioned into a "0-output group" of m-n ports and a "1-output group" of n output ports, and (3) routing the maximum possible total number of 0-bound and bicast signals to the 0-output group and the maximum possible total number of 1-bound and bicast signals to the 1-output group, as recited in claim 4.

As discussed above, Lee does not disclose a bicast input signal. Further, the switch elements disclosed by Lee merely partition the output ports into addressable ports and a bypass port such that the bypass port receives packets contending for an addressable port. Accordingly, Lee's switch elements do not partition the output ports into 0-bound ports and 1 bound ports such that a control signal routes the input signals to the respective 0-bound ports and

1-bound ports. Also, Lee does <u>not</u> teach or suggest any processing which would route the maximum possible total number of 0-bound and bicast ones of the input signals to the 0-bound group and the maximum possible total number of 1-bound and bicast ones of the input signals to the 1-output group, as recited in claim 4.

The Examiner further states that while Lee does not disclose bicast signals for routing in a multistage interconnection network, but that Yang et al. discloses a system and method for assigning a routing tag for routing signals through a Benes network comprising 2x2 Beta elements wherein the routing tags and the comparator generate different control sequences for each input signal to support grouping channels, e.g. multicasting.

Yang et al. discloses a Benes network comprising m control stages and n self routing stages. The path of an input is determined by a binary control sequence of length m to which is appended a binary address of the output port of length m. A plurality of output channels are organized into a plurality of channel groups wherein each of the channel groups is associated with one or more unique output ports of the Benes network. Only an output port not yet selected for another input queue, associated with a channel group to which a cell to be outputted from the queue is destined, may be selected.

The Examiner appears to be stating that the switch elements disclosed by Yang et al. support bicast signals by reference to col. 10, lines 40-53. However, this is clearly not the case. <u>The description at col. 10, lines 40-53 describes the switching of a unicast signal through two consecutive Beta elements</u> where a "0" switches an input signal to the "0" (upper) output port and a "1" switches the signal to a "1" (lower) output port (col. 10, lines 40-44) and does not describe a <u>bicast signal</u> nor a <u>bicast element</u>. Fig. 11 clearly shows the control signals 00, 01, 10 and 11 control the switches in Yang et als'. network to be in either a bar state or a cross state and never in a state which <u>simultaneously</u> connects a single input to more than a single output. Consequently, one of ordinary skill in the art would have to conclude that Yang et al. does not teach or suggest the routing of bicast signals.

In order to support a bicast signal, a switch element must have a connection state that simultaneously connects an input bicast signal on one input of the switch element to both the "0" output and the "1" output of the switch element. As described at col. 10, lines 29-38

however, the switching element used by Yang et al. is a Beta element. Such an element can only be set in a bar state or a cross state. (See col. 6, lines 34-35). Such a configuration does not have a state which connects one input to both outputs as required for multicasting.

Further, the grouping of switches disclosed by Yang et al. into upper and lower Benes networks is <u>not</u> based on the rule recited in claim 4. The partitioning recited in claim 4 divides the output ports into a "0-output group" and a "1-output group" to which signals are routed based on whether they are "0 bound" (i.e. bound for the 0-ouput group) or "1 bound" (i.e. bound for the 1-output group) or bicast (bound for both the 0-output group and the 1 output group). In contrast, signals in Yang et al. are routed to the upper and lower subnetworks based on properties 1 and 2 described at col. 11, lines 20-43. Properties 1 and 2 are related to resolving contention and do not provide for multicasting.

Neither Lee nor Yang et al. teach or suggest a <u>multicast</u> concentrator. Further, neither Lee nor Yang teach or suggest the structure recited in claim 4. Specifically, neither Lee nor Yang et al. teach or suggest a switch having m output ports partitioned into two groups, where <u>m-n of the m output ports are grouped as a 0-output group and the remaining n output ports are grouped as a 1-output group</u>, and means, responsive to the input signals, for <u>routing the maximum possible total number of 0-bound and bicast ones of the input signals to the 0-output group and the maximum possible total number of 1-bound and bicast ones of the input signals to the 1-output group</u>.

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). MPEP 2142.

Applicant submits that there is no teaching or suggestion in Lee or in the

knowledge generally available to one of ordinary skill in the art to modify the bypassing Omega network disclosed by Lee to incorporate the Benes network disclosed by Lee. Further, there would be no motivation to combine the methods of Lee and Yang et al. since they both attempt to solve the same problem <u>by a completely structure and by different methods</u>, Lee by using a self routing network in which packets are routed by a routing tag using a 3X3 element with a bypass port to which conflicting packets are routed and Yang et al. which utilizes 2X2 switching elements, in a control subnetwork added to the self routing network, the states of the control network being controlled by control bits which are appended to the routing tag.

Also, the likelihood of success for combining Lee and Yang et al. is almost nonexistent because the networks of Lee and Yang et al. are incompatible. Lee uses 3X3 elements in an Omega network in which the connections between the elements in connected stages are a perfect shuttle. In contrast, Yang et al. teaches a Benes network which uses as a basis, cross coupled 2X2 elements.

Further, and most important, even if the teachings of Lee and Yang et al. were combined in the manner suggested by the Examiner, the combination of Lee and Yang et al. does not meet all the claim limitations. Neither Lee nor Yang et al. disclose: (1) a multicast switching element and therefore the combination could not replicate a multicast concentrator; (2) a bicast signal or (3) means for routing the maximum possible total number of 0-bound and bicast ones of the input signals to the 0-output group and the maximum possible total number of 1-bound and bicast ones of the input signals to the 1-output group.

Applicant submits that the combination of Lee and Yang et al. does not make claim 4 obvious. Accordingly, Applicant respectfully requests reconsideration and withdrawal of the § 103 rejection of claim 4.

Claim 9 recites:

A method for implementing an <u>m-to-n multicast concentrator</u> with reference to the network topology of an m-to-n concentrator, the m-to-n concentrator having m-n output ports grouped as a 0-output group and n output ports grouped as a 1-output group and

constructed from a multi-stage interconnection network of sorting cells, the method comprising:

constructing a multi-stage interconnection network of nodes having the same network topology as the multi-stage interconnection network of the m-to-n concentrator, and

filling each of the nodes of the constructed network with a bicast cell.

Claim 9 recites an m-n multicast concentrator having m-n output ports grouped as a 0-output group and n output ports grouped as a 1-output group. Neither Lee nor Yang et al. teach or suggest the structure of a multicast concentrator. Accordingly, claim 9 is allowable for the same reasons that claim 4 is allowable.

In addition, claim 9 recites that each of the nodes is filled with a bicast cell. As described at pages 168 to 170, when a bicast cell receives a bicast signal and an idle signal, the bicast cell routes the bicast signal to both the 0 output and the 1 output. If on the other hand, a bicast and a unicast signal are received, the unicast signal is routed to its intended output and the bicast signal is routed to the alternate output.

As discussed above, the 3X3 cell described by Lee merely partitions the output ports into addressable ports and a bypass port such that the cell routes a packet to a single addressable output port or to a bypass port if there is contention for the addressable port and never routes a signal to more than one output port. Further, the switching element used by Yang et al. is a Beta element which is described as an element that can only be set in a bar state or a cross state, again having the capability of routing an input to only a single output port. Accordingly, neither Lee nor Yang et al. disclose, teach or suggest a bicast cell.

Applicant submits that the combination of Lee and Yang et al. does not make claim 9 obvious. Accordingly, for all the above reasons, Applicant respectfully requests reconsideration and withdrawal of the § 103 rejection of claim 9.

Allowable Subject Matter

The Examiner objected to claims 5-8 as being dependent upon a rejected base claim but stated that claims 5-8 would be allowable if rewritten in independent form including all the limitations of the base claim and any intervening claims. Claim 4 has been shown to be allowable. Consequently, claims 5-8 dependent on claim 4 are allowable, at least by their dependency on allowable claim 4. Accordingly, for all the above reasons, Applicant respectfully requests reconsideration and withdrawal of the objection to claims 5-8.

Conclusion

Insofar as the Examiner's objections and rejections have been fully addressed, the instant application, including claims 4-11, is in condition for allowance and Notice of Allowability of claims 4-11 is therefore earnestly solicited.

Respectfully submitted,

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